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Sinopsis

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The idea of this book is to illustrate an interplay between distinct domains of mathematics. Firstly, this book provides an introduction to hyperbolic geometry, based on the Lorentz group PSO(1, d) and its Iwasawa decomposition, commutation relations and Haar measure, and on the hyperbolic Laplacian. The Lorentz group plays a role in relativistic space-time analogous to rotations in Euclidean space. Hyperbolic geometry is the geometry of the unit pseudo-sphere. The boundary of hyperbolic space is defined as the set of light rays. Special attention is given to the geodesic and horocyclic flows. This book presents hyperbolic geometry via special relativity to benefit from physical intuition. Secondly, this book introduces some basic notions of stochastic analysis: the Wiener process, Itô's stochastic integral and Itô calculus. The book studies linear stochastic differential equations on groups of matrices, and diffusion processes on homogeneous spaces. Spherical and hyperbolic Brownian motions, diffusions on stable leaves, and relativistic diffusion are constructed. Thirdly, quotients of hyperbolic space under a discrete group of isometries are introduced, and form the framework in which some elements of hyperbolic dynamics are presented, especially the ergodicity of the geodesic and horocyclic flows. An analysis is given of the chaotic behaviour of the geodesic flow, using stochastic analysis methods. The main result is Sinai's central limit theorem. Some related results (including a construction of the Wiener measure) which complete the expositions of hyperbolic geometry and stochastic calculus are given in the appendices